Citation:

Woo J, Ho SC, Yu AL, Sham A. Is waist circumference a useful measure in predicting health outcomes in the elderly? *Int J Obes Relat Metab Disord.* 2002; 26: 1,349-1,355.

PubMed ID: 12355330

Study Design:

Longitudinal, observational study

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To examine the effect of age on the relationship between body mass index (BMI), waist circumference (WC) and the usefulness of BMI, WC and waist-to-hip ratio (WHR) in predicting mortality and cardiovascular risk in an elderly population.

Inclusion Criteria:

- Chinese individuals, at least 70 years old, on a registered list of Old Age and Disability Allowance recipients (henceforth referred to as "Elderly")
- Random sample of younger adults participating in a community dietary survey in 1995 (henceforth referred to as "Younger Adults").

Exclusion Criteria:

- Elderly
- Very rich elderly not choosing to claim allowance and therefore, not on allowance recipient list
- Approximately 40% of men and women who did not reply to recruitment letter or accept study screening interview.

Description of Study Protocol:

Recruitment

- Elderly
- Enough letters sent to those on allowance recipient list to acquire 300 subjects of each gender in the 70 to 74 year and 75 to 79 year age groups and 150 subjects of each gender in the 80 to 84, 85 to 89, 90 year and older age groups.

Design

Elderly

- A questionnaire concerning medical history completed by interviewers at the subjects' place of residence
- Height and weight measured in indoor clothing without shoes using a digital standing scale and tape measure attached to wall
- WC: Measure at minimum circumference between the umbilicus and xiphoid process and measured to nearest 0.5cm
- Hip circumference: Measured at maximum circumference around the buttocks posteriorly and the symphysis pubis anteriorly and measured to nearest 0.5cm
- WHR: Calculated as waist divided by hip circumferences
- BMI: Body weight (kg)/height $(m)^2$
- Blood pressure: Measured using a mercury sphygmomanometer in the seated position
- Regression line of WC against BMI was drawn, perpendicular lines from BMI of 25 and 30kg/m^2 intercepting the regression line marked, then horizontal lines from intercept points drawn to y-axis to determine corresponding WC measurements. Similar graph was constructed to determine the WC corresponding to BMI values of 25 and 30kg/m^2 for Younger Adults sample
- To compare accuracy and determine BMI and WC cut-off values predicting mortality and cardiovascular risk, Elderly cohort was re-interviewed, reported diagnosis (by a doctor) of diabetes mellitus or hypertension noted, and blood pressure measured after three years
- Hypertension: Reported diagnosis of hypertension or a reading of SBP>140 or DBP>90mmHg
- Deaths: Documented information from relatives or search of death registries.

Dietary Intake/Dietary Assessment Methodology

Not applicable.

Blinding Used

Not applicable.

Intervention

Not applicable.

Statistical Analysis

- ANOVA: Examine differences in mean values
- Chi-square tests: Examine differences in mortality and presence of hypertension and diabetes
- Multiple stepwise logistic regression: Examine relationships between BMI and WC, mortality and presence of hypertension and diabetes mellitus at 36 months
- Receiver operating characteristic curve (ROC) analysis: Used to derive cut-off values with optimal sensitivity and specificity for the three anthropometric measures in predicting outcomes in men and women separately
- The likelihood ratios (LR) of death at 36 months, having hypertension or diabetes were calculated across a range of each anthropometric measurement by dividing sensitivity by (1-specificity).

Data Collection Summary:

Timing of Measurements

Elderly: At baseline and three years later.

Dependent Variables

- BMI
- Waist circumference
- Waist-to-hip ratio.

Independent Variables

- Mortality at 36 months
- Presence of diabetes mellitus
- Presence of hypertension.

Control Variables

None specified.

Description of Actual Data Sample:

- *Initial N:*
  - Elderly: Stratified random sample of 2,032 subjects interviewed and examined at baseline; 1,690 after 36 months of follow-up
  - Younger Adults: 1,010 subjects used for comparison of BMI to WC relationship
- *Attrition (final N):* None listed
- *Age:*
  - Elderly: 80.1±7.5 years
  - Younger Adults: 45.5±11.6 years
- *Ethnicity:* Chinese
- *Other relevant demographics:* None listed
- *Anthropometrics:*
  - BMI
  - WC
  - Waist-to-hip ratio
- *Location:* Not specified.

Summary of Results:

- Even in the absence of disease, three times as many subjects lost at least 5kg in weight as gained at least 5kg (15% vs. 5%)
- Waist circumference values corresponding to BMI of 25 and 30kg/m^2 were higher in elderly (92 and 103 cm for men; 88 and 99cm for women) compared with younger subjects (85 and 97cm for men; 78 and 88cm for women)
- Women had statistically significant higher BMI than men, but lower WHR compared with men; there were no statistical differences in waist or hip circumference or WHR between genders

- Number of deaths due to cancer and cardiovascular diseases was 21 and 25.3% among men, and 17.9 and 29.5% among women, respectively
- BMI and WC were inversely associated with mortality in both men and women and positively associated with diabetes in men but not in women
- WC was positively associated with hypertension in men and women
- WHR was not associated with any outcome measures
- Among subjects with stable weight, the relationship between anthropometric indices and outcome remained the same for women; among men, the only significant relationship was between BMI and mortality
- The optimal WC and WHR cut-off values for predicting hypertension in men had low optimal sensitivity; for women, BMI and WHR cut-off values had low optimal sensitivity or specificity, especially for predicting hypertension or diabetes
- Regarding the likelihood ratio for mortality, presence of hypertension or presence of diabetes at 36 months, the predominant pattern was:
    - Increase in mortality with lower BMI, WC and WHR values
        - BMI: Curve for mortality started to rise with values below 23kg/m^2 for men and women
        - WC and WHR: Inverse trend observed with gender differences; WC was higher and WHR lower in women compared with men
        - Presence of hypertension: Little relationship to any anthropometric indice
    - Gradual increase in presence of diabetes with increasing BMI in both men and women and increasing WC and WHR in men only
- Mortality and diabetes curve cross over:
    - Optimum BMI: 21kg/m^2 for men, 25kg/m^2 for women
    - Optimum WC: for men=80-85cm
    - Optimum WHR: 0.88-0.90
    - ROC cut-off values: WC and WHR values higher and BMI values lower in Elderly versus Younger Adult populations; optimal sensitivity and specificity for cut-off values were higher in Younger Adult vs. Elderly population
- If subjects with diabetes and hypertension at baseline were excluded, among the 1171 subjects alive at 36 months, 838 subjects would be excluded from analyses, leaving 333 subjects (169 men, 164 women). Association between the three anthropometric indices at baseline and hypertension at 36 months was examined by logistic regression; no significant association was present between any of these indices and hypertension in women. In men, a positive association with WC (OR 1.05, 95% CI 1.01-1.08, P=0.011) and with WHR (OR 458.9, 95%CI 2.33-90,344.8, P=0.023) was observed.

Author Conclusion:

- Inverse relationship between BMI and WC, and mortality was observed; no relationship observed between WHR and mortality
- Observed WC corresponding to BMI of 25 and 30kg/m^2 being higher in Elderly compared with Younger Adults is compatible with other studies
- Since cardiovascular risk is related to visceral fat mass, use of anthropometric indices not expected to predict risk well in individuals at least 70 years old; lack of cut-off values with good sensitivity and specificity in predicting hypertension and diabetes in the Elderly vs. Younger Adult population supports this view
- Anthropometric values in study could serve as indicators for risk of mortality in elderly Chinese populations; however, use of WC and WHR as screening measurements for

cardiovascular risk factors such as hypertension and diabetes are of limited use. Relationship may be distorted by survivor effect (more subjects with hypertension or diabetes may have died during the follow-up period than those without these diseases)
- In spite of limitations, authors conclude that while WC may be a useful indication of visceral obesity and predictor of cardiovascular risk in middle age subjects, the relationship may not apply to old-old subjects of at least 80 years
    - Waist measurements corresponding to overweight and obese BMI values were higher and offered no advantage to BMI in cardiovascular risk prediction
    - WHR measurement was not a useful screening tool for the detection of cardiovascular risks. The positive association between WC and WHR, and diabetes in men appears to be a continuous one analogous to the health risks associated with HbA1c values
- BMI of 21kg/m^2 for men and 25kg/m^2 for women may be considered as optimum values for minimal mortality and reduced risk of developing diabetes
- Waist measurement values for predicting health outcomes in elderly people aged 70 years and over are different compared with Younger Adults and have similar predictive accuracy compared with BMI.

Reviewer Comments:

- *Sample sizes were often different in tables vs. text. For example, final sample size confusing: Authors provide statistics in tables for 1,690 elderly subjects (859 women; 831 women) at 36 months follow-up, yet indicate in the text that only 1,170 subjects (558 men, 612 women) were available for re-interview*
- *Study limitations:*
    - *Selection bias: Recruitment covered those on the disability allowance and there may have been over-representation of subjects with debilitating diseases*
    - *Presence or absence of hypertension and diabetes was not confirmed by physicians' examination, but relied on self-report of doctor's diagnosis*
        - *or diagnosis of hypertension: Diagnostic accuracy is improved by blood pressure measurement*
        - *For diabetes: Without blood glucose measurement, up to 50% may remain undetected. Thus, association between diabetes and three anthropometric indices would have been stronger:*
            - *Increasing likelihood ratio with increasing BMI in spite of statistical significance not being reached*
            - *Increasing likelihood ratio for WC and WHR in men; since pattern not present in women, it is likely even if diabetes was diagnosed using blood glucose measurements, waist and WHR are probably not useful predictors in women*
        - *Associations between anthropometric measurements at baseline and three years may have been affected by the number of subjects lost to follow-up:*
            - *Comparison of subjects lost to follow-up vs. study subjects showed former:*
                - *Had higher mean age*
                - *No difference in frequency of hypertension and diabetes at baseline*
                - *Association between anthropometric measures and mortality would likely be accentuated by inclusion of these subjects since they were older*
            - *Blood specimens were not collected as part of the survey and therefore relationships between anthropometric indices and lipid abnormalities*

could not be examined.

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions		
1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes
Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	No
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A

3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	No
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	Yes
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A

6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	N/A
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	Yes
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	No
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	No
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	No

8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	No
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes